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An Experimental Study on the Utilization of Marble and Granite Waste Slurry in Manufacturing of Bricks

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ABSTRACT: The stone industries have not only provided occupation to large number of people but also produces various stone used to build monuments. This increasing popularity of the marbles, growing demand for finished and unfinished products, discovery of new marble deposits have led to a significant growth in Marble Industry. As a result, numbers of marble quarries and marble processing units have significantly gone up during last one decade. This leads to simultaneous rise in waste generation as well, thereby causing concern towards the deteriorating environmental quality. A wide spread need is being felt to make this industry environmentally sustainable. The aim of this study is to find an economical and sustainable way to get rid of the marble slurry and granite slurry generated in the stone industries. It proposes the use of waste marble slurry and granite powders to clay in clay bricks. This study will lead to an important effect on the economics of clay which will be replaced by cheap marble and granite waste from stone industry. And the problem of waste stone slurry would be solved drastically by use of marble and granite waste in the clay brick as brick is the most widely used construction material at present. In this study I found that 10 % replacement of clay with granite slurry and marble slurry gives maximum compressive strength. After 15%, the compressive strength starts decreasing in both granite and sand replacement. Whereas water absorption observed for both replacement granite and marble decreases up to 10 % after that increases. Density of brick after replacement of granite continuously decreases and after replacement marble continuously increases.

Keywords: Bricks, Clay, Kiln, Marble, Granite, Compressive Strength, Density, Water Absorption

I. INTRODUCTION

Brick is one of the important materials for construction industry. The conventional method of manufacturing bricks has left this important material aloof in advancement. The infrastructure such as buildings for housing and industry, and the facilities for handling water and sewage will require large amounts of construction materials. Since the large demand has been placed on building material industry especially in the last decade owing to the increasing population, there is a mismatch between demand-supply management of these materials. Hence to meet the continuously increasing demand, researchers are attempting to design and develop sustainable alternative solutions for the construction material. The increase in the popularity of using environmental friendly, low cost and lightweight construction materials in building industry has brought about the need to investigate how this can be achieved by benefiting to the environment as well as maintaining the material requirements affirmed in the standards. Brick is one of the most accommodating masonry units as a building material due to its properties. Attempts have been made to incorporate waste in the production of bricks, for instance, the use of paper processing residues, cigarette butts, fly ash, textile effluent treatment plant (ETP) sludge, polystyrene foam, plastic fiber straw, polystyrene fabric, cotton waste, dried sludge collected from industrial wastewater treatment plant, rice husk ash, granulated powder mixtures were compressed in a hydraulic press, and the green bodies were dried before firing at 1100°C.

Brick making is as ancient as human civilization itself. Great architectural wonders and the immortal monuments built in the antique past had been built with bricks besides stones and mortar. Ever since man realized the housing as basic need, he started using bricks in various forms like green bricks, sun dried bricks and the fired bricks.

Today from the humble dwellings to the modern skyscrappers and labyrinthine structures, brick forms the most important building material. Like the earth withstanding the passage of unimaginable astronomical years, the bricks also, made of earth's clay and soil do withstand even the worst disastrous onslaughts of nature for quite a long time. Myths abound with information about the usage of bricks even in the building of Babel Tower by the King Solomen.

Today, one cannot imagine a construction at the exclusion of bricks and such is the importance that bricks have assumed as a building material. In any country, construction accounts for about 60 per cent of the plan outlays all over the world. Out of this, bricks account for more than forty percent. Brick manufacturing has become important in the context of providing shelter which is an important basic human need next to food and clothing. Besides shelter, bricks are being used in the development of infrastructure such as construction of dams, canals and business houses which are needed for improvement in the levels of living of the people everywhere.

In the commercial market, brick is still a leading wall cladding material. Brick making is a traditional unorganized industry, generally confined to rural and semi urban areas. It is one of the largest employment generating industries, employing millions of workers. Brick, being one of the oldest building materials is extensively used at present as a main input in construction because of its durability, strength, reliability, low cost and easy availability. Brick industry, which is essentially a labour intensive industry, provides employment opportunity to a vast work force of around several millions of people in India.

II. EXPERIMENTAL PROGRAMME

The main objective of this study is to obtain a gainful utilization of waste stone powder as a part substitute of constituents of Clay brick and to study and analyze the effects of stone slurry on properties of bricks. Also, this study assesses the properties of the final product after incorporating waste stone powder. Ultimately, the incorporation of waste powder in Brick industry could lead to a viable, environmentally friendly material with attractive properties. This is achieved through a series of steps which including:

a) To study the influence of percentage replacement of clay by marble waste powder in clay brick and studying compressive strength, water absorption and efflorence of clay bricks
b) To study the effects of percentage replacement of clay by granite waste powder in clay bricks and studying compressive strength, water absorption and efflorence of clay bricks.

Table 1: Chemical composition of Clay, Granite slurry and Marble Slurry Powder.

Compound	Marble	Granite	Clay
SiO_2	10.41	73.19	65.04
CaO	31.33	20.14	4.12
MgO	20.91	Nil	1.96
Loss of Ignition (LOI)	37.20	0.53	5.66
Fe_2O_3	Nil	5.93	5.06
Al_2O_3	Nil	Nil	12.95

III. EQUATION

Specific Gravity Test for Clay, Granite slurry and Marble Slurry Powder

Specific gravity of aggregates and marble slurry powder was tested using pycnometer test and Le-Chatelier's test was performed for specific gravity of cement. The formula used to calculate the specific gravity is: –

$$sp.gr. = \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)\rho}$$

Where, W_1 = Weight of Pycnometer in gm
W_2 = Weight of Pycnometer + aggregate in gm
W_3 = Weight of Pycnometer + aggregate + water in gm
W_4 = Weight of Pycnometer + water in gm.
ρ = density of medium

After adding water, pycnometer was rotated so that all the voids get filled with water and all the air bubbles come on the surface. Again water was poured to fill the pycnometer completely.

The test results for coarse and fine aggregates, cement and marble slurry are as follows –

S. No.	Weight combinations	weight (gm)
1	Weight of Pycnometer (W_1)	657
2	Weight of Pycnometer + Clay (W_2)	1157
3	Weight of Pycnometer + Fine Aggregate + Water (W_3)	1853
4	Weight of Pycnometer + Water (W_4)	1543
5	**Specific Gravity of Clay**	**2.63**

S. No.	Weight combinations	weight (gm)
1	Weight of pycnometer (W_1)	657
2	Weight of pycnometer + Marble Slurry Powder (W_2)	1157
3	Weight of pycnometer + Marble Slurry Powder + Water (W_3)	1859
4	Weight of pycnometer + Water (W_4)	1543
5	**Specific Gravity of Marble Powder**	**2.72**

S. No.	Weight combinations	weight (gm)
1	Weight of pycnometer (W_1)	657
2	Weight of pycnometer + Marble Slurry Powder (W_2)	1157
3	Weight of pycnometer + Marble Slurry Powder + Water (W_3)	1848.5
4	Weight of pycnometer + Water (W_4)	1543
5	Specific Gravity of Marble Powder	2.613

IV. RESULTS AND DISCUSSION

Mechanical and Physical Properties of clay bricks

Compressive Strength

Compressive strength is strongly influenced by the characteristics of the raw material and by the production process. It is known that the raw clay of old bricks was often of low quality and the manufacturing process was relatively primitive and inefficient. Other characteristics of existing old bricks can provide an indication about compressive strength, such as mineral composition, texture, crack pattern and porosity level, by revealing the conditions of drying and firing. An average compressive strength of 12.5–27.5 MPa and 34.5 MPa respectively, was found.

Water Absorption

The acceptable water absorption for clay bricks are between 12% and 20%. If you are using engineering bricks the closer you are to the 12% the better the result will be. When the water absorption is too low, i.e. below 12%, it may be difficult to obtain a proper bond between the mortar and the bricks.

Density of Bricks

Usually sulphate of magnesium, calcium, sulphate and carbonate (and sometimes chloride and nitrates) of sodium and potassium are found in efflorescence. These salts may be traced to the brick itself, sand used in construction, the foundation soil, ground water, water used in the construction and loose earth left over in contact with brick work. Bricks with magnesium sulphate content higher than 0.05 percent should not be used in construction. Soluble salt content in sand (chloride and sulphate together) should not exceed 0.1 percent.

Compressive Strength –

Table 1: Marble Replacement in Clay Bricks.

Sample	Marble Replacement(%)	Compressive Strength (N/mm^2)
M0	0	12.23
M5	5	12.71
M10	10	13.29
M15	15	13.95
M20	20	12.01
M25	25	10.73

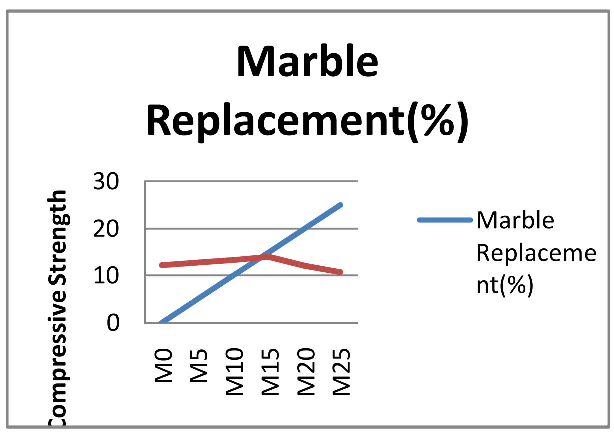

Fig. 1

Table 2: Granite Replacement in Clay Bricks.

Sample	Granite Replacement(%)	Compressive Strength (N/mm^2)
G0	0	12.23
G5	5	12.94
G10	10	13.71
G15	15	12.01
G20	20	11.18
G25	25	9.07

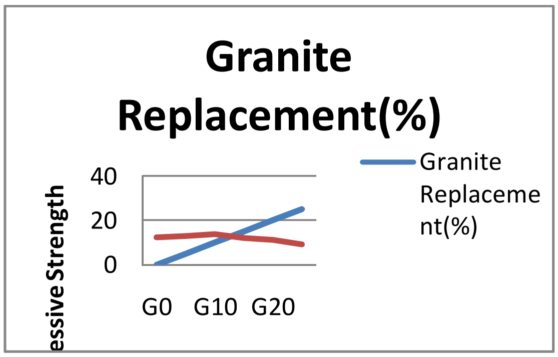

Fig. 2

We can conclude that, at 10 % replacement of clay with granite slurry and marble slurry gives maximum compressive strength. After 15%, the compressive strength starts decreasing in both granite and sand replacement.

Water Absorption

Table 3: Marble Replacement in clay bricks.

Sample	Marble Replacement(%)	Water Absorption (%)
M0	0	13.67
M5	5	13.10
M10	10	12.11
M15	15	13.71
M20	20	14.95
M25	25	15.30

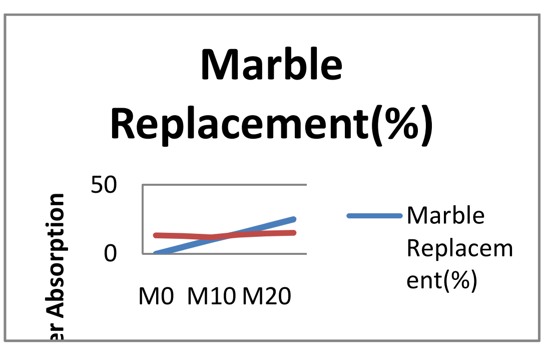

Fig. 3.

Table 4: Granite Replacement in clay bricks.

Sample	Granite Replacement(%)	Water Absorption (%)
G0	0	13.67
G5	5	12.86
G10	10	12.41
G15	15	13.69
G20	20	15.71
G25	25	16.22

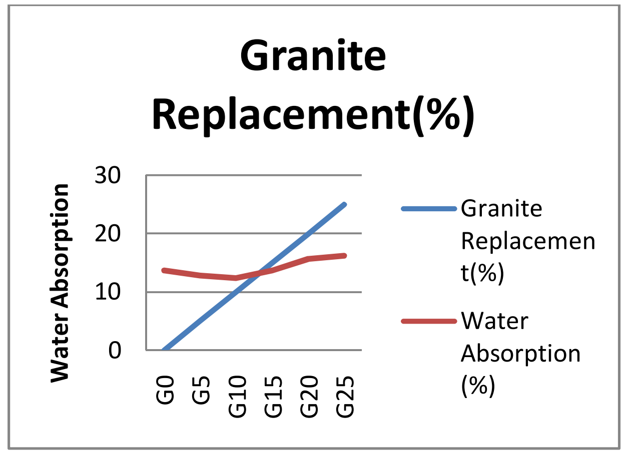

Fig. 4

Water absorption observed for both replacement granite and marble decreases up to 10 % after that increases.

Density-

Table 5: Marble Replacement in clay bricks.

Sample	Marble Replacement(%)	Density (kg/m^3)
M0	0	1241
M5	5	1253
M10	10	1257
M15	15	1263
M20	20	1271
M25	25	1287

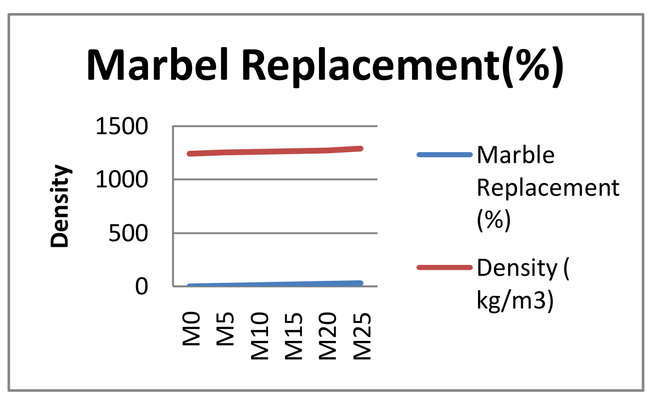

Fig. 5

Table 6: Granite Replacement in clay bricks.

Sample	Granite Replacement(%)	Density (kg/m^3)
G0	0	1241
G5	5	1239
G10	10	1222
G15	15	1217
G20	20	1207
G25	25	1197

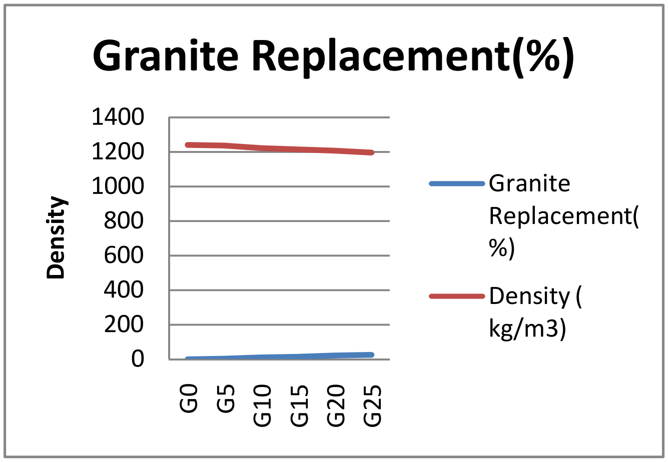

Fig. 6.

Density of brick after replacement of granite continuously decreases and after replacement marble continuously increases.

V. CONCLUSION

(i) After collecting and analyzing all the results, we can conclude that, at 10 % replacement of clay with granite slurry and marble slurry gives maximum compressive strength. After 15%, the compressive strength starts decreasing in both granite and sand replacement.
(ii) Water absorption observed for both replacement granite and marble decreases up to 10 % after that increases.
(iii) Density of brick after replacement of granite continuously decreases and after replacement marble continuously increases.
(vi) So we can analyzed that 10 % replacement of marble and granite slurry is optimum.

VI. FUTURE SCOPE

(i) Detailed microscopic study can be done to know the reason of changes in behavior of bricks.
(ii) A study can be done related to durability of bricks.

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